

Next Generation Neutron and Gamma-Ray Spectrometer for Planetary Spacecraft

Completed Technology Project (2015 - 2018)



Project Introduction

We propose to develop a passive and active source neutron and gamma-ray spectrometer to characterize the abundance of near-surface hydrogen and rock-forming elements on a variety of spacecraft missions to planetary bodies (Moon, Mars, NEOs, comets). The instrument (initially at TRL-2) will use a new type of scintillator, Cs₂YLiCl₆:Ce (CLYC). CLYC is self-annealing at room temperature and provides both high efficiency detection of neutrons and excellent energy resolution for gamma-rays. The proposed work will investigate the use of a CLYC scintillator with a cosmic-ray background source as well as with an active pulsed neutron generator (PNG) source of neutrons for geochemical analysis. Our goal is to progress the overall instrument package (detector and PNG) to TRL-4. The ability of CLYC to detect both neutrons and gamma-rays (with a photomultiplier tube) has been demonstrated via a previously awarded NASA SBIR to RMD, thus we assert CLYC at TRL-3. The use of CLYC with a PNG is at TRL-2, and our proposal will develop timing-based electronics for the coupled system and perform testing in a laboratory environment, resulting in an overall instrument at TRL-4.

Description of Methodology to be used: Task 1: Monte-Carlo modeling to determine optimal detector size based on minimum planetary radius and mission parameters as well as a science trade study of D-D vs. D-T pulsed neutron source with variable pulse rates and length. Task 2: Development of methods for maintaining high-performance characteristics of a CLYC detector in the space environment. Task 3: Development of integrated detector and electronics modules capable of operating in both passive and active source modes. Task 4: Testing of the integrated detector and electronics system with an isotopic and pulsed neutron source.

Description of Relevance to PICASSO: This work supports the goals of PICASSO as it increases the TRL of a platform-independent (orbital or surface) instrument that is well suited for several medium-class planetary missions in NASA's Decadal Survey. For example, several science mission objectives specifically referred to by NASA are geochemical characterization during a comet sample return mission, a Trojan Tour and Rendezvous mission, and a rover-based Lunar South Pole-Aitken Basin sample return mission. The geochemical data provided by this instrument would directly address NASA's goals and objectives to 'characterize the chemical composition of comets', and to 'determine water resources in lunar polar regions and near-Earth asteroids'.

Anticipated Benefits

The results of this project will be a combined neutron and gamma-ray instrument using one detector that can be flown on future planetary rovers and landers to Mars, the Moon, or planets/moons with thick atmospheres like Titan or Venus to determine bulk geochemistry and water content. The instrument does not need to be deployed, does not require any optics and will provide rapid characterizations of the hydrogen content, depth of hydrated layers and bulk rock-forming element geochemistry at the rover/lander scale.



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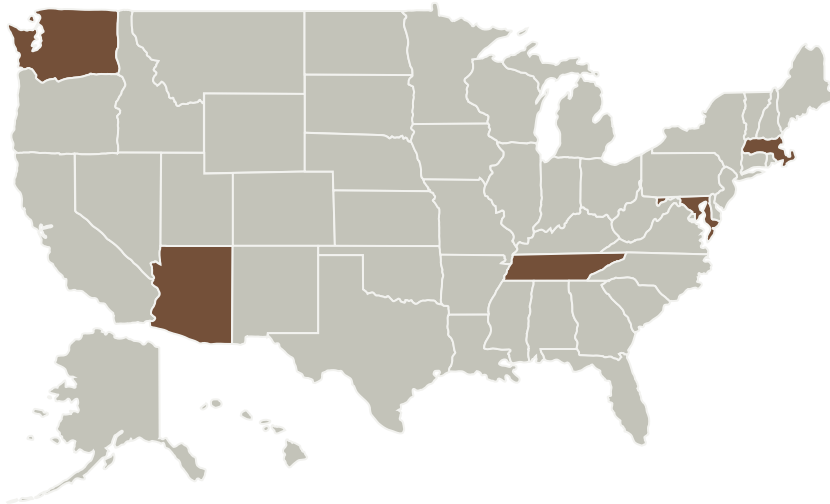
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Arizona State University-Tempe(ASU)	Lead Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Tempe, Arizona

Primary U.S. Work Locations	
Arizona	Maryland
Massachusetts	Tennessee
Washington	

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Arizona State University-Tempe (ASU)

Responsible Program:

Planetary Instrument Concepts for the Advancement of Solar System Observations

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Haris Riris

Principal Investigator:

Craig J Hardgrove

Co-Investigators:

Sarah Gates
Hugh J Barnaby
Jeffrey E Moersch
Matthew Beasley
Chad M Whitney
Thomas H Prettyman
James Christian
Ann M Parsons
James F Bell
Erik B Johnson

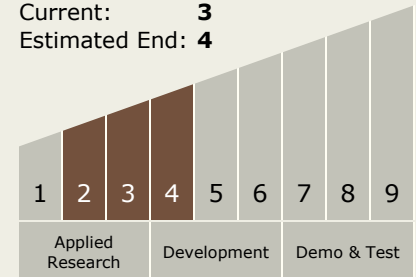
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Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
 - └ TX07.1 In-Situ Resource Utilization
 - └ TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destination

Others Inside the Solar System